

CLAIMS

1. A semiconductor wafer cleaning formulation for use in semiconductor fabrication comprising an unsaturated dicarboxylic acid, and ethylene urea.
2. The cleaning formulation according to claim 1, wherein the formulation is an aqueous solution.
3. The cleaning formulation according to claim 2, comprising 1-9% by weight of an unsaturated dicarboxylic acid; and 1-20% by weight of ethylene urea.
4. The cleaning formulation according to claim 2, further comprising at least one organic carboxylic acid except unsaturated dicarboxylic acid, and at least one basic compound except ethylene urea.
5. The cleaning formulation according to claim 4, comprising 1-9% by weight of an unsaturated dicarboxylic acid; 1-20% by weight of ethylene urea; 1-20% by weight of at least one organic carboxylic acid except unsaturated dicarboxylic acid; 0.1-50% by weight of at least one basic compound except ethylene urea; and 20-90% by weight of water.
6. The cleaning formulation according to claim 4, wherein the unsaturated dicarboxylic acid is selected from the group consisting of maleic acid and citraconic acid.
7. The cleaning formulation according to claim 4, wherein the unsaturated dicarboxylic acid is maleic acid.
8. The cleaning formulation according to claim 4, wherein the organic carboxylic acid is selected from the group consisting of:
 - formic acid (FA),
 - acetic acid (AA), and

propionic acid (PA).

9. The cleaning formulation according to claim 4, wherein the basic compound is selected from the group consisting of:

- hydroxyethylpiperazine (HEP),
- hydroxypropylpiperazine (HPP),
- aminoethylpiperazine (AEP),
- aminopropylpiperazine (APP),
- hydroxyethylmorpholine (HEM),
- hydroxypropylmorpholine (HPM),
- aminoethylmorpholine (AEM),
- aminopropylmorpholine (APM),
- triethanolamine (TEA),
- pentamethyldiethylenetriamine (PMDETA),
- dimethylaminoethoxyethanol (DMAEE),
- aminoethoxyethanol (AEE),
- trimethylaminoethylethanolamine (TMAEEA),
- trimethylaminopropylethanolamine (TMAPEA),
- N-(2-cyanoethyl)ethylenediamine (CEEDA),
- N-(2-cyanopropyl)ethylenediamine (CPEDA), and
- ammonia (NH₃).

10. The cleaning formulation according to claim 4, further comprising at least one selected from the group consisting of:

- an organic solvent,
- a chelating agent,
- a surfactant, and
- phosphonic acid and/or phosphinic acid.

11. The cleaning formulation according to claim 10, wherein 1-20% by weight of the organic solvent, 0.01-5% by weight of the chelating agent, 0.01-0.2% by weight of the surfactant, and 0.5-5% by weight of phosphonic acid and/or phosphinic acid are contained.

12. The cleaning formulation according to claim 10, wherein the organic solvent is

selected from the group consisting of:

1,4-butanediol (1,4-BD),
1,3-butanediol (1,3-BD),
ethylene glycol (EG),
propylene glycol (PG),
N-methylpyrrolidone(NMP),
 γ -butyrolactone (GBL),
propylene glycol monomethylether (PGME), and
propylene glycol monomethylether acetate (PGMEA).

13. The cleaning formulation according to claim 10, wherein the chelating agent is selected from the group consisting of:

ascorbic acid,
gluconic acid,
mannitol,
sorbitol, and
boric acid.

14. The cleaning formulation according to claim 10, wherein the surfactant is a C_{1-10} alkyl glucoside.

15. A method for cleaning a semiconductor wafer comprising:
cleaning the wafer by using a chemical formulation comprising an unsaturated dicarboxylic acid, and ethylene urea in semiconductor fabrication.

16. The method according to claim 15, wherein the formulation is an aqueous solution.

17. The method according to claim 16, wherein the formulation comprises
1-9% by weight of an unsaturated dicarboxylic acid; and
1-20% by weight of ethylene urea.

18. The method according to claim 16, wherein the formulation further comprises:
at least one organic carboxylic acid except unsaturated dicarboxylic acid, and

at least one basic compound except ethylene urea.

19. The method according to claim 18, wherein the formulation comprises:
 - 1-9% by weight of an unsaturated dicarboxylic acid;
 - 1-20% by weight of ethylene urea;
 - 1-20% by weight of at least one organic carboxylic acid except unsaturated dicarboxylic acid;
 - 0.1-50% by weight of at least one basic compound except ethylene urea; and
 - 20-90% by weight of water.
20. The method according to claim 18, wherein the unsaturated dicarboxylic acid is selected from the group consisting of maleic acid and citraconic acid.
21. The method according to claim 18, wherein the unsaturated dicarboxylic acid is maleic acid.
22. The method according to claim 18, wherein the organic carboxylic acid is selected from the group consisting of:
 - formic acid (FA),
 - acetic acid (AA), and
 - propionic acid (PA).
23. The method according to claim 18, wherein the basic compound is selected from the group consisting of:
 - hydroxyethylpiperazine (HEP),
 - hydroxypropylpiperazine (HPP),
 - aminoethylpiperazine (AEP),
 - aminopropylpiperazine (APP),
 - hydroxyethylmorpholine (HEM),
 - hydroxypropylmorpholine (HPM),
 - aminoethylmorpholine (AEM),
 - aminopropylmorpholine (APM),
 - triethanolamine (TEA),
 - pentamethyldiethylenetriamine (PMDETA),
 - dimethylaminoethoxyethanol (DMAEE),

aminoethoxyethanol (AEE),
trimethylaminoethylethanolamine (TMAEEA),
trimethylaminopropylethanolamine (TMAPEA),
N-(2-cyanoethyl)ethylenediamine (CEEDA),
N-(2-cyanopropyl)ethylenediamine (CPEDA), and
ammonia (NH₃).

24. The method according to claim 18, wherein the formulation further comprises at least one selected from the group consisting of:

an organic solvent,
a chelating agent,
a surfactant, and
phosphonic acid and/or phosphinic acid.

25. The method according to claim 24, wherein 1-20% by weight of the organic solvent, 0.01-5% by weight of the chelating agent, 0.01-0.2% by weight of the surfactant, and 0.5-5% by weight of phosphonic acid and/or phosphinic acid are contained.

26. The method according to claim 24, wherein the organic solvent is selected from the group consisting of:

1,4-butanediol (1,4-BD),
1,3-butanediol (1,3-BD),
ethylene glycol (EG),
propylene glycol (PG),
N-methylpyrrolidone(NMP),
γ-butyrolactone (GBL),
propylene glycol monomethylether (PGME), and
propylene glycol monomethylether acetate (PGMEA).

27. The method according to claim 24, wherein the chelating agent is selected from the group consisting of:

ascorbic acid,
gluconic acid,
mannitol,

sorbitol, and
boric acid.

28. The method according to claim 24, wherein the surfactant is a C₁₋₁₀alkyl glucoside.

29. A method for cleaning a semiconductor wafer comprising:
cleaning the wafer by using a chemical formulation comprising an unsaturated dicarboxylic acid, and ethylene urea, in a cleaning process after a following process:
(i) making via hole;
(ii) making trench;
(iii) punching of etch stopper layer; or
(iv) CMP (chemical mechanical polishing) process.

30. The method according to claim 29, wherein the formulation is an aqueous solution.

31. The method according to claim 30, wherein the formulation comprises
1-9% by weight of an unsaturated dicarboxylic acid; and
1-20% by weight of ethylene urea.

32. The method according to claim 30, wherein the formulation further comprises:
at least one organic carboxylic acid except unsaturated dicarboxylic acid, and
at least one basic compound except ethylene urea.

33. The method according to claim 32, wherein the formulation comprises:
1-9% by weight of an unsaturated dicarboxylic acid;
1-20% by weight of ethylene urea;
1-20% by weight of at least one organic carboxylic acid except unsaturated dicarboxylic acid;
0.1-50% by weight of at least one basic compound except ethylene urea; and
20-90% by weight of water.

34. The method according to claim 32, wherein the unsaturated dicarboxylic acid is selected from the group consisting of maleic acid and citraconic acid.

35. The method according to claim 32, wherein the unsaturated dicarboxylic acid is maleic acid.

36. The method according to claim 32, wherein the organic carboxylic acid is selected from the group consisting of:

- formic acid (FA),
- acetic acid (AA), and
- propionic acid (PA).

37. The method according to claim 32, wherein the basic compound is selected from the group consisting of:

- hydroxyethylpiperazine (HEP),
- hydroxypropylpiperazine (HPP),
- aminoethylpiperazine (AEP),
- aminopropylpiperazine (APP),
- hydroxyethylmorpholine (HEM),
- hydroxypropylmorpholine (HPM),
- aminoethylmorpholine (AEM),
- aminopropylmorpholine (APM),
- triethanolamine (TEA),
- pentamethyldiethylenetriamine (PMDETA),
- dimethylaminoethoxyethanol (DMAEE),
- aminoethoxyethanol (AEE),
- trimethylaminoethylethanolamine (TMAEEA),
- trimethylaminopropylethanolamine (TMAPEA),
- N-(2-cyanoethyl)ethylenediamine (CEEDA),
- N-(2-cyanopropyl)ethylenediamine (CPEDA), and
- ammonia (NH₃).

38. The method according to claim 32, wherein the formulation further comprises at least one selected from the group consisting of:

- an organic solvent,
- a chelating agent,
- a surfactant, and

phosphonic acid and/or phosphinic acid.

39. The method according to claim 38, wherein 1-20% by weight of the organic solvent, 0.01-5% by weight of the chelating agent, 0.01-0.2% by weight of the surfactant, and 0.5-5% by weight of phosphonic acid and/or phosphinic acid are contained.

40. The method according to claim 38, wherein the organic solvent is selected from the group consisting of:

1,4-butanediol (1,4-BD),
1,3-butanediol (1,3-BD),
ethylene glycol (EG),
propylene glycol (PG),
N-methylpyrrolidone(NMP),
 γ -butyrolactone (GBL),
propylene glycol monomethylether (PGME), and
propylene glycol monomethylether acetate (PGMEA).

41. The method according to claim 38, wherein the chelating agent is selected from the group consisting of:

ascorbic acid,
gluconic acid,
mannitol,
sorbitol, and
boric acid.

42. The method according to claim 38, wherein the surfactant is a C₁₋₁₀alkyl glucoside.